Poster 2-6
NSC

A near real time regional satellite data assimilation system at CIMSS for research and applications on using JPSS and GOES-R measurements

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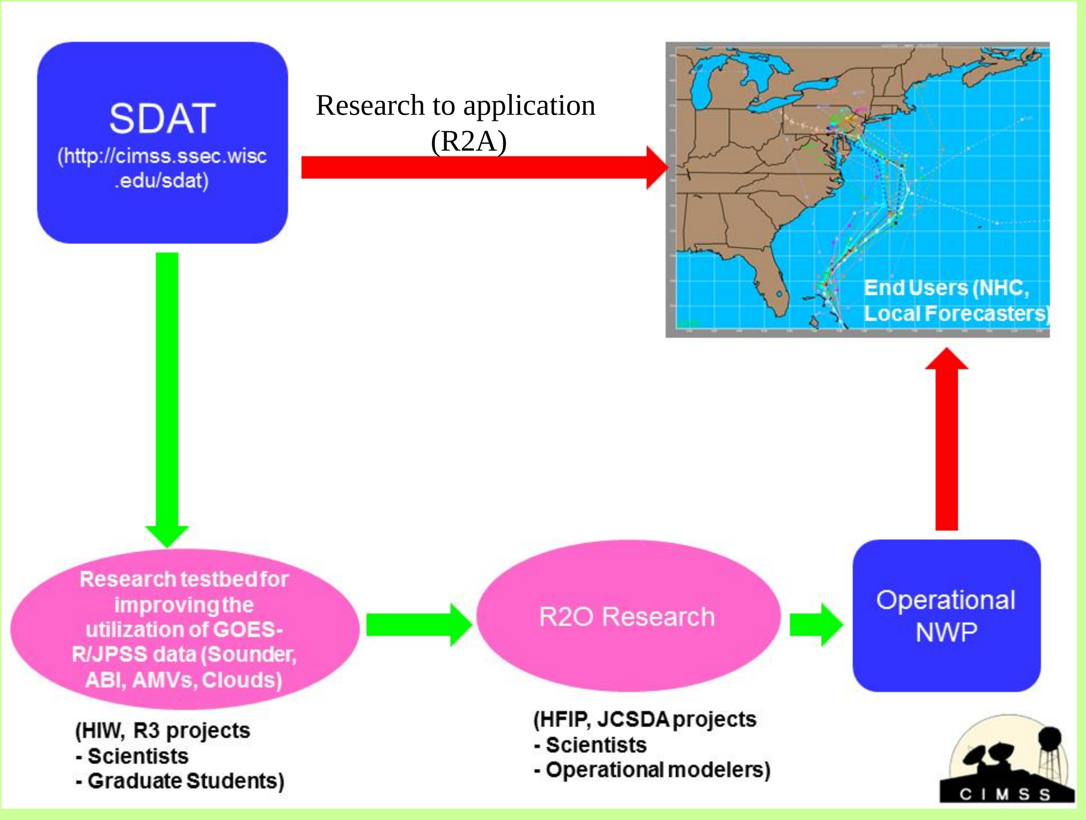
Motivation

- Develop a near real time (NRT) system called SDAT (Satellite Data Assimilation for Tropical storm forecasts) with optimal configurations on the assimilation of satellite data (radiance and/or retrievals), for high impact weather (e.g., TC) research and applications;
- Collaborate with end users (e.g., NHC) to make direct applications of SDAT forecasts in NRT;
- Serve as research testbed for improving the assimilation of satellite data (JPSS and GOES-R) in regional NWP (e.g., handling clouds, using high temporal and spatial resolution WV and AMV information, etc.);
- Provide a pathway towards advanced satellite data assimilation in operational TC forecast models (i.e. HWRF).



1. Satellite Data Assimilation for Tropical storms (SDAT) - A real time system based on WRF/GSI (http://cimss.ssec.wisc.edu/sdat)

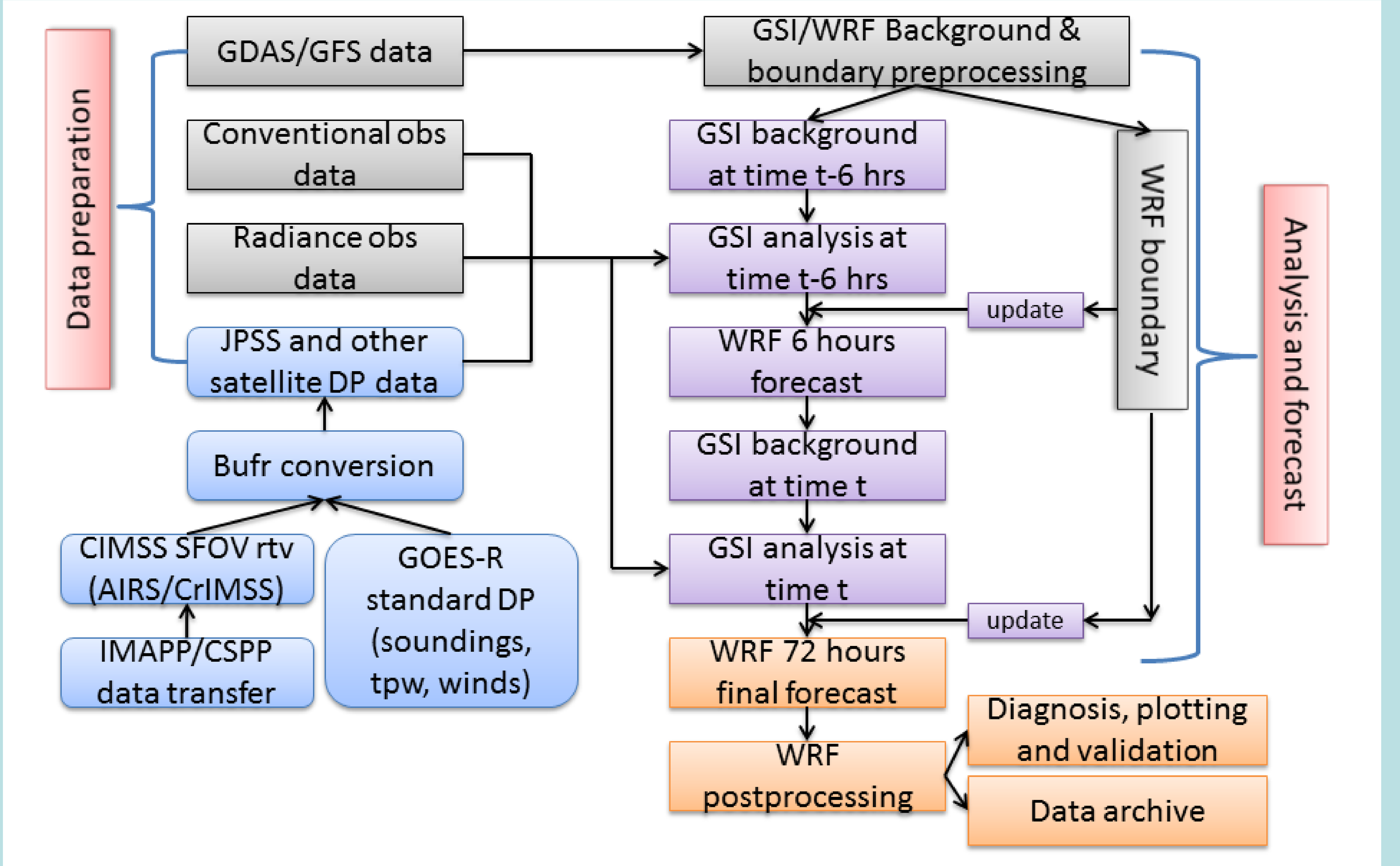
A regional Satellite Data Assimilation system for Tropical storm forecasts (SDAT) (http://cimss.ssec.wisc.edu/sdat) has been developed and running in near real time (NRT) at CIMSS since August 2013, SDAT forecasts have been available in near real time to ATCF (Automatic Tropical Cyclone Forecast) that the National Hurricane Center (NHC) uses since October 2014;

Based on WRF/GSI, conventional and satellite observations including GOES Sounder, AMSU-A (N15, N18, N19, metop-a, aqua), ATMS (Suomi-NPP), HIRS4 (N19, metop-a), AIRS (aqua), IASI (metop), and MHS (N18, N19, metop) are assimilated;

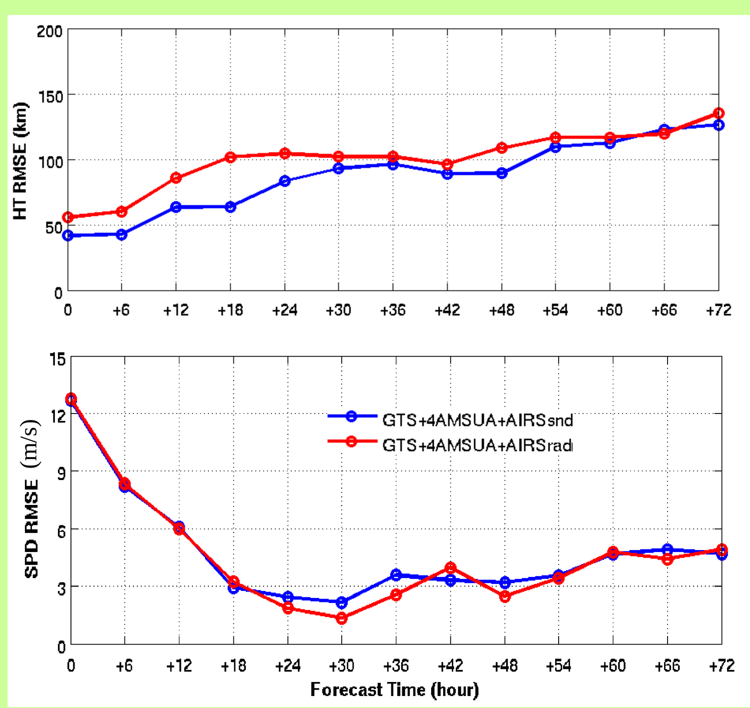
"Tracker" program was implemented since October 2013 for post processing;

Layer Precipitable Water (LPW) forward operator has been developed and implemented within GSI for assimilating high temporal resolution GOES Sounder and GOES-R water vapor information;

SDAT has been used as a research testbed, for example, research has been conducted using SDAT on radiance assimilation versus sounding assimilation, and handling clouds when assimilating hyperspectral IR radiances (Li et al. 2004; Wang et al. 2014, 2015; Han et al. 2015), rapid scan AMVs.



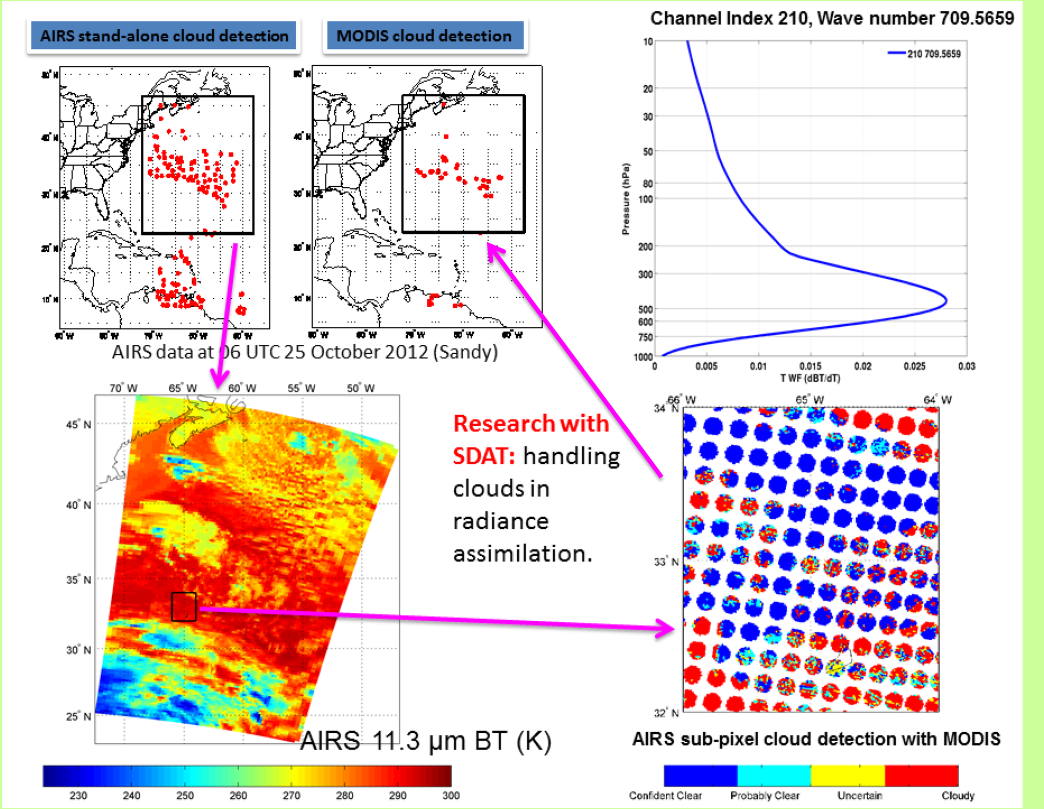
2. Radiance assimilation versus retrieval assimilation



Track (upper) and maximum wind speed (lower) RMSE from SDAT forecasts. Data are assimilated every 6 hours from 06 UTC 25 to 00 UTC 27 October 2012, followed by 72-hour forecasts. The data assimilated includes conventional data, AMSU-A radiances from Aqua, NOAA (-15, -18), and Metop-A satellites, plus AIRS radiances (red) and AIRS single FOV soundings (blue).

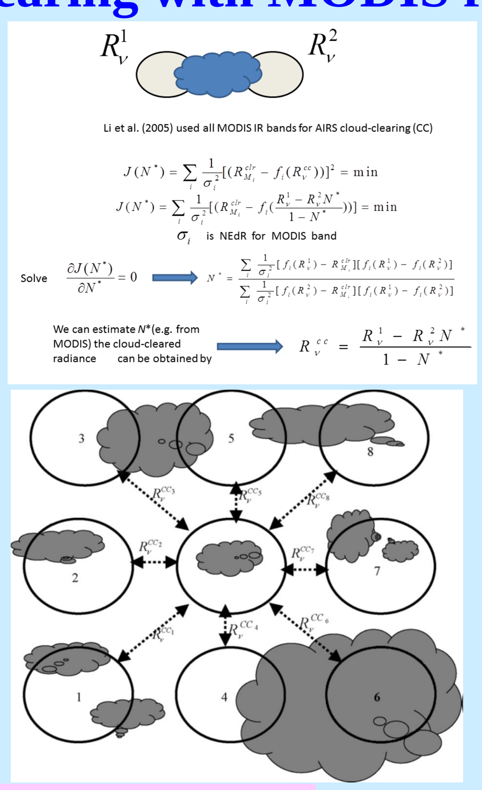
3. Handling clouds in hyperspectral IR radiance assimilation

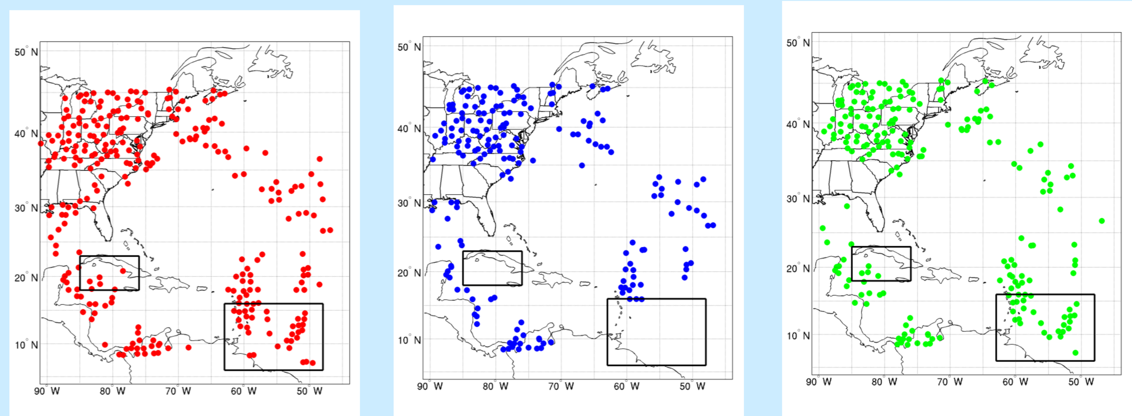
(a) Black cloud assumption (rise the surface to cloud-top);
(b) Clear pixel detection: Stand-alone cloud detection with sounder data, sub-pixel cloud detection with collocated high spatial resolution imager data (Li et al. 2004; Wang et al. 2014);
(c) Using clear channel in cloudy region: Cloud-removal or cloud-clearing technique that transform a cloud radiance spectrum to a clear equivalent radiance spectrum on IR single field-of-view (SFOV) basis (Li et al. 2005; Wang et al. 2015);
(d) Use radiative transfer model under cloudy situations for direct assimilating the cloudy radiances.



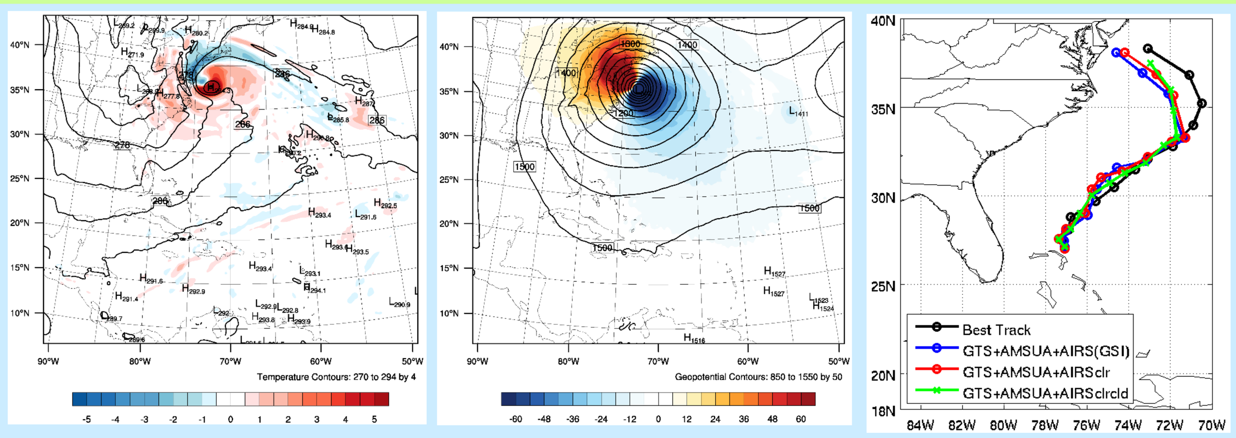
4. AIRS cloud-clearing with MODIS for radiance assimilation under cloudy skies

The direct assimilation of IR radiances is challenging because both NWP and radiative transfer models have large uncertainties in cloud situations; algorithm for AIRS cloud-clearing with MODIS has been developed; for each partly cloudy footprint, find the best R^{cc} from 8 pairs to represent the cloud-cleared clear equivalent radiance spectrum for assimilation.

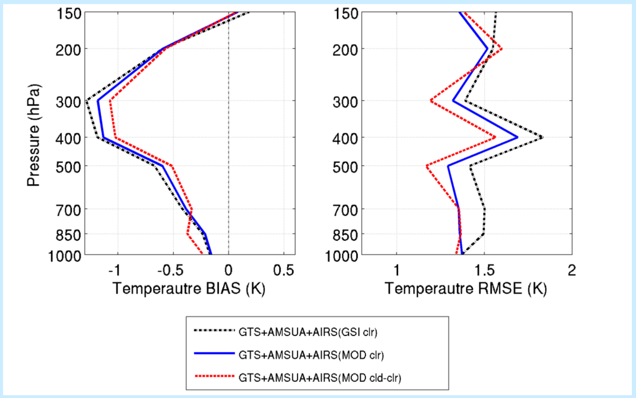




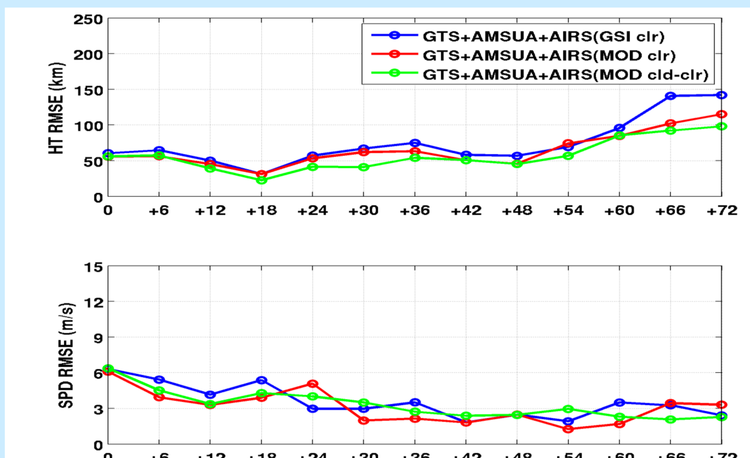
The locations at 18 UTC 25 Oct 2012 where AIRS channel 210 (709.566 cm^{-1}) is assimilated in GSI for AIRS (GSI clr) (left red), AIRS (MOD clr) (middle blue) and AIRS (MOD cld-clr) (right green).
GSI clr: GTS+AMSUA+AIRS (GSI stand-alone cloud detection)
MOD clr : GTS+AMSUA+AIRS (MODIS for cloud detection)
MOD cld-clr: GTS+AMSUA+AIRS (MODIS for cloud detection and cloud-clearing)



The differences in temperature (left shaded, unit: K) and geopotential height (middle shaded, unit: m) at 850 hPa at 18 UTC 29 Oct 2012 for the 72-hour forecasts between AIRS (MOD cld-clr) and AIRS (MOD clr), along with the hurricane tracks (right) for 72-hour forecasts from 1800 UTC 26 October to 1800 UTC 29 Oct 2012.

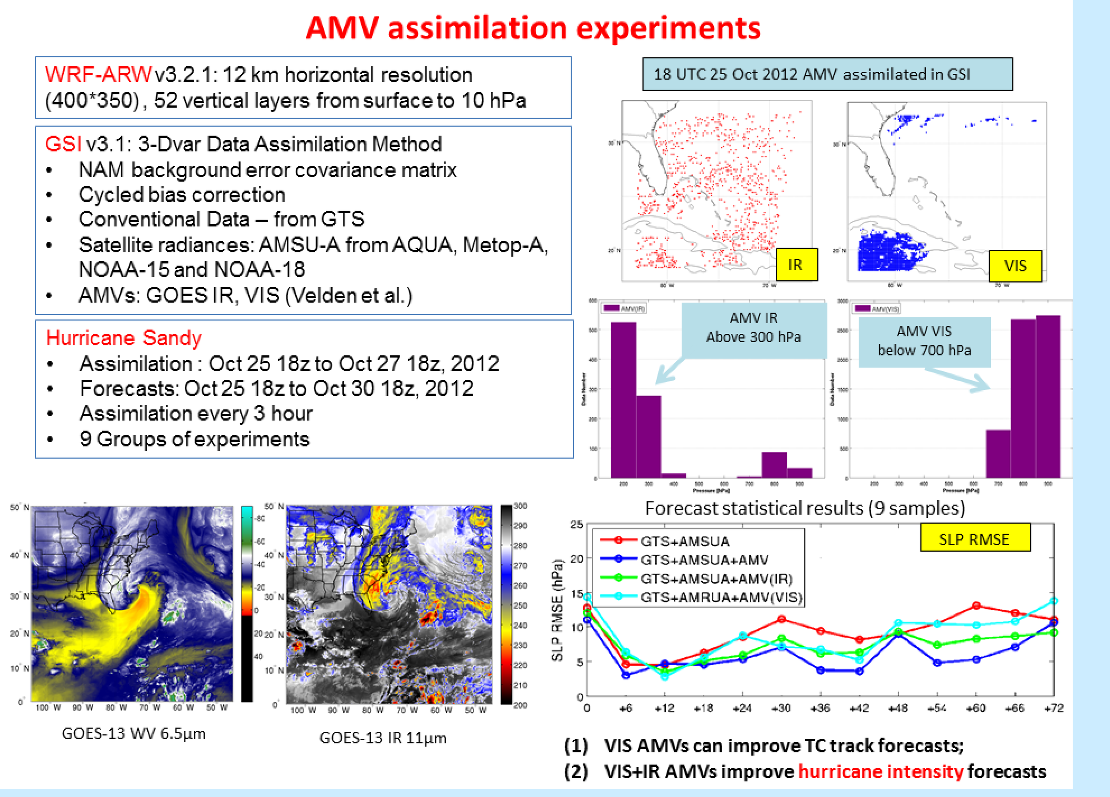


BIAS (left) and RMSE (right) for 72-hour forecasts of temperature profiles from AIRS (GSI clr), AIRS (MOD clr), and AIRS (MOD cld-clr) for Hurricane Sandy (2012). Radiosondes are used as reference.



The track (top) and maximum wind speed (bottom) forecast RMSE with AIRS (GSI clr), AIRS (MOD clr) and AIRS (MOD cld-clr). Data are assimilated every 6 h from 18 UTC on 25 October to 00 UTC on 27 Oct 2012, followed by 72 hour forecasts (Sandy).

5. Using GOES/GOES-R rapid scan AMVs



5. References

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